STUDY OF THE $U(p, K^+)$ REACTION AT T_p =1.0 GeV AND 1.5 GeV *

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The report is presented about first results on measurements of hypernuclei produced by the internal proton beam on uranium target.

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Nowadays, the investigation of strangeness concentrates on strange matter aspects. Thus hypernuclei, where strange particles (hyperons) are embedded in nonstrange nuclear matter, have become an object of intensified interest. In this contribution we report first results on the measurement of hypernuclei produced by the internal proton beam in the COSY accelerator ring.

The COSY-13 project has the dedicated goal to measure $\sigma_{\Lambda}A$ and $\tau_{\Lambda}A$, *i.e.*the cross section for the production of heavy hypernuclei and the lifetime of hypernuclei, respectively. Both of these observables are of high interest: the first should help in clarifying the leading mechanism of the production

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of hypernuclei, the second is required for the investigation of weak decay matrix elements in the nuclear medium.

Λ-hyperons are expected to be produced with rather high rates [1] (cross section in the order of few hundred microbarns) in proton induced reactions on heavy targets (*e.g.*U) already at energies slightly below the threshold for Λ K^+ production in nucleon - nucleon collisions. The hyperons are produced with some distribution in kinetic energy relative to the target at rest ([1]), however, only a small fraction of them can be bound by the attractive nuclear field when excluding final state interactions. Thus the process of hyperon-nucleon rescattering is essential in decreasing the hyperon momentum with repect to the target frame of reference in order to get the hyperon bound in the target.

$$\boxed{\mathrm{p} + \mathrm{A} \rightarrow \mathrm{K}^+ + \Lambda + \mathrm{A} \xrightarrow[\text{rescattering}]{} {}_{\Lambda}\mathrm{A'}}$$

$$\sigma_{K^+} \approx \sigma_\Lambda$$

$$\sigma_{{}_\Lambda A} \approx \sigma_\Lambda \times \mathrm{SP}$$

(SP - sticking probability)

The theoretical estimates for the Λ sticking probability have been presented in [2] for different proton energies, e. g. on a uranium target, with and without taking into account this rescattering effect:

T_p / GeV	σ_Λ	$SP_{without\_resc.}$	$SP_{with\_resc.}$	$\sigma_{{}_\Lambda A}$
1.5	440. μb	0.01	0.25	110. μb
1.0	0.80 μb	0.10	0.41	0.32 μb

As it is clearly seen from the above results, Λ-nucleon rescattering dramatically enhances (by about a factor of 25) the cross section for the production of hypernuclei at T_p = 1.5 GeV. At the proton energy T_p = 1.0 GeV the predicted cross section is distinctly below 1 μb even when including rescattering [2].

In Fig. 1 we show the experimental setup. An internal proton beam hits the target; the hypernuclei produced leave the target flying forward with some distribution in velocity. After time $\tau_{\Lambda A}$ the Λ hyperon decays inside the nucleus, exciting the former hypernucleus which consequently breaks into fragments. With a geometrical efficiency one of the fragments can be registered by the two multi-wire proportional chambers (MWPC) operating

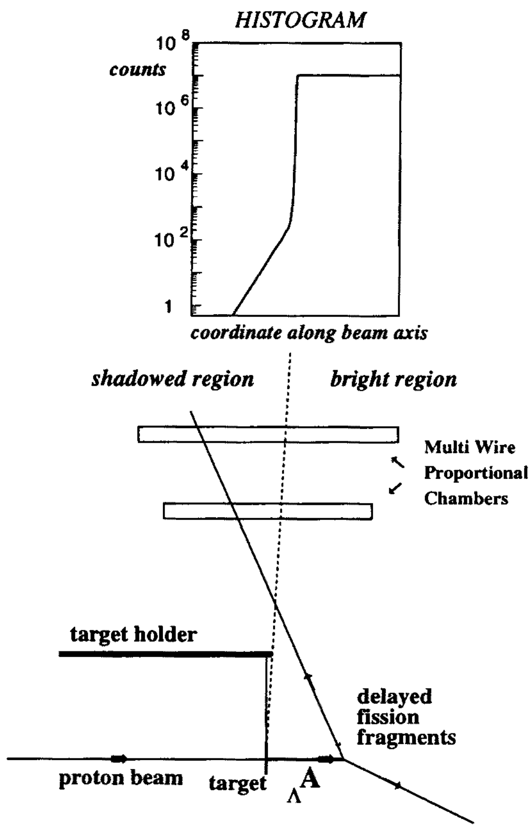

Fig. 1. Experimental setup

in coincidence. On the other hand, the proton beam also produces fast fission fragments which can reach the MWPC's as well. However, only the delayed fission fragments can reach the shadowed region of the detectors. Now the detectors can be divided into shadowed and bright regions, where the latter is defined as the sector that can register fragments coming directly from the target region. A monitor detector (avalanche counter), which is placed in front of the MWPC's, helps to determine the boundary of both regions since it can sustain high counting rates of fragments. In the top of Fig. 1 a sample (ideal) histogram of fragment hits on the lower MWPC

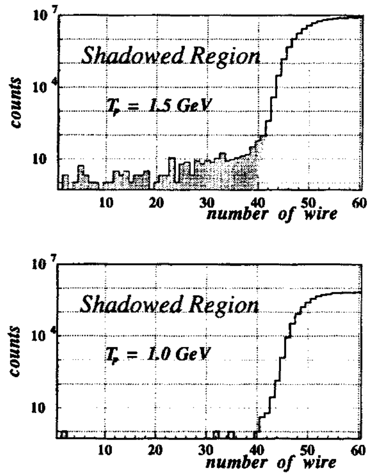

Fig. 2. Preliminary data

is shown. The events forming the tail in the shadowed region then can be interpreted as a signal of decaying hypernuclei.

A few characteristics of the detectors used are:

Multi Wire Proportional Chambers
upper detector 170mm × 340mm
lower detector 100mm × 200mm
isobutan 4 mbar
high voltage 500 V
span between wires 1mm
read-out of wires: delay lines

counting efficiency for fission fragments $\simeq$ 100 %

counting efficiency for electrons and protons $< 2 \times 10^{-11}$

In Fig. 2 we show the experimental histograms after trajectory reconstruction for two energies of the proton beam. Contrary to $T_p = 1$ GeV at $T_p = 1.5$ GeV many events appear in the shadowed region giving a clear signal of decaying hypernuclei. The actual magnitude of the respective cross section, however, requires further efforts in the data analysis.

In summary, with the shadow method employed one is able to handle a dynamical range of the data of 10^7 (the ratio of events in the shadowed and bright regions of the detector). The fact that only very few events are observed at T_p = 1.0 GeV confirms that conventional fission isomers of a lifetime comparable to the lifetime of hypernuclei are not produced (cross section ¡ 1μb). Delayed events observed at T_p = 1.5 GeV show that Λ-nucleon rescattering enhances the cross section for the production of hypernuclei substantially, qualitatively in line with [1, 2]. The quantitative analysis is in preparation.

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